

PATENT COOPERATION TREATY

CORRECTED VERSION

From the
INTERNATIONAL SEARCHING AUTHORITY

PCT

To:

see form PCT/ISA/220

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY
(PCT Rule 43bis.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No. PCT/IB2004/000439	International filing date (day/month/year) 20.02.2004	Priority date (day/month/year)
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International Patent Classification (IPC) or both national classification and IPC
H04L25/03, H04L27/26, H04B3/14

Applicant
NOKIA CORPORATION

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☒ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application



2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

<p>Name and mailing address of the ISA:</p>  <p>European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465</p>	<p>Authorized Officer</p> <p>Baltersee, J</p> <p>Telephone No. +49 89 2399-7126</p> 
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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**International application No.
PCT/B2004/000439

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ in written format
 - ☐ in computer readable form
 - c. time of filing/furnishing:
 - ☐ contained in the international application as filed.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

**WRITTEN OPINION OF THE
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Box No. II Priority

1. ☒ The following document has not been furnished:

☒ copy of the earlier application whose priority has been claimed (Rule 43*bis*.1 and 66.7(a)).

☐ translation of the earlier application whose priority has been claimed (Rule 43*bis*.1 and 66.7(b)).

Consequently it has not been possible to consider the validity of the priority claim. This opinion has nevertheless been established on the assumption that the relevant date is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43*bis*.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.

3. ☐ It has not been possible to consider the validity of the priority claim because a copy of the priority document was not available to the ISA at the time that the search was conducted (Rule 17.1). This opinion has nevertheless been established on the assumption that the relevant date is the claimed priority date.

4. Additional observations, if necessary:

**WRITTEN OPINION OF THE
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Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of:

- ☐ the entire international application,
- ☒ claims Nos. 3, 4, 17, 18, 31, 32

because:

- ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):
- ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):
- ☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.
- ☒ no international search report has been established for the whole application or for said claims Nos. 3, 4, 17, 18, 31, 32
- ☐ the nucleotide and/or amino acid sequence listing does not comply with the standard provided for in Annex C of the Administrative Instructions in that:
 - the written form ☐ has not been furnished
 - ☐ does not comply with the standard
 - the computer readable form ☐ has not been furnished
 - ☐ does not comply with the standard
- ☐ the tables related to the nucleotide and/or amino acid sequence listing, if in computer readable form only, do not comply with the technical requirements provided for in Annex C-bis of the Administrative Instructions.
- ☐ See separate sheet for further details

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/IB2004/000439

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees, the applicant has:
- ☐ paid additional fees.
 - ☒ paid additional fees under protest.
 - ☐ not paid additional fees.
2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.
3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is
- ☐ complied with
 - ☒ not complied with for the following reasons:
see separate sheet
4. Consequently, this report has been established in respect of the following parts of the international application:
- ☒ all parts.
 - ☐ the parts relating to claims Nos.

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	7-10, 13, 17, 18, 21, 23, 27, 31, 32, 35, 37, 41
	No: Claims	1, 2, 5-6, 11, 12, 14-16, 19-20, 25, 26, 28-30, 33-34, 39, 40, 42, 43
Inventive step (IS)	Yes: Claims	9, 23, 37
	No: Claims	1, 2, 5-8, 10-16, 19-22, 24-30, 33-36, 38-43
Industrial applicability (IA)	Yes: Claims	1, 2, 5-16, 19-30, 33-43
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item IV

Lack of unity of invention

1. Multiple inventions were found in this international application, as follows:

1. Claims 1, 2, 5-7, 9, 11-16, 19-21, 23, 25-30, 33-35, 37, 39-43

Phase equalizer

2. Claims 8, 10, 22, 24, 36, 38

Amplitude equalizer

The application lacks unity within the meaning of Rule 13 PCT. In the light of the relevant prior art document D2, an objection of *a posteriori* lack of unity arises (see PCT Guidelines, Gazette, Section IV, III 7.5). The reasons therefor are the following:

2. The following prior art document was found during the search and proved to be relevant for assessment of unity of the above cited inventions.

D2: US-A-5 555 285 (TAPIA JAVIER J ET AL) 10 September 1996 (1996-09-10)

The document D2 discloses (the references in parentheses applying to this document) according to all features of claim 1,

Document D2 discloses, according to all the features of claim 1,

Method for use in an equalization of a channel by means of an equalizer, wherein said channel uses a certain frequency band for a transfer of signals (see column 3, lines 50-61), said method comprising:

- determining a channel response for at least one frequency point within said frequency band used by said channel (see column 25, lines 41-60 which shows that the frequency response is measured at P points of the frequency spectrum in question); and

- setting at least one adjustable coefficient of said equalizer such that an equalizer response compensates optimally the determined channel response at said at least one selected frequency point (see column 25, line 55-60 which shows an equation to calculate N equalizer coefficients based on P measured points of the frequency spectrum; see also column 14, lines 12-15 which discloses using the equalizer coefficients to compensate for the channel response)

Independent claims 15, 29 and 43 contain essentially the same technical features as claim 1. Therefore, document D2 discloses all the features of these claims as well.

It follows from a comparison of the present set of claims with document D2 that the following technical features could potentially make a contribution over this prior art, and as such may be regarded as special technical features in the sense of Rule 13.2 PCT:

- Claims 7, 9, 21, 23, 35, 37: Setting said adjustable coefficients comprises for an equalization of the phase of said channel setting a complex coefficient as a phase rotator part of said equalizer and setting at least one coefficient of a complex allpass filter part of said equalizer
- Claims 8, 10, 22, 24, 36, 38: Setting said adjustable coefficients comprises for an equalization of the amplitude of said channel setting at least one coefficient of a symmetric Finite Impulse Response filter part of said equalizer

A comparison reveals that there is no technical relationship among these inventions involving one or more of the same special technical features (Rule 13.2 PCT).

The objective technical problems which are solved by the special technical features of inventions 1. and 2. may be regarded as follows:

- Invention 1.: How to equalize the phase distortions of a channel?
- Invention 2.: How to equalize the amplitude distortions of a channel?

The problems underlying inventions 1. and 2. are completely unrelated to each other, and thus none of the potential special technical features of the two respective inventions may be regarded to function in an equivalent, or complementary, or cooperative manner, nor are they specially adapted to each other. Therefore, no corresponding special technical features in the sense of Rule 13.2 PCT can be ascribed to the inventions 1. and 2.

3. The (group of) inventions 1. and 2. are thus neither linked by a single general inventive concept, nor do they fulfil the requirement of Rule 13.2 PCT that an international patent application may include a group of inventions if there is a technical relationship among those inventions involving **one or more of the same, or corresponding special technical features** which make as a whole a inventive contribution to the state of the art.

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

- D1: IHALAINEN T; HIDALGO-STITZ T; RENFORS M: "On the Performance of Low-Complexity ASCET-Equalizer for a Complex Transmultiplexer in Wireless Mobile Channel" 7TH INTERNATIONAL OFDM WORKSHOP 2002, 11 September 2002 (2002-09-11), XP002299814 HAMBURG, GERMANY
- D2: US-A-5 555 285 (TAPIA JAVIER J ET AL) 10 September 1996 (1996-09-10)
- D3: US 2004/008618 A1 (HAYASHINO HIROSHI ET AL) 15 January 2004 (2004-01-15)
- D4: NEZAMI M K ED - INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS: "Techniques for acquiring and tracking MIL-STD 181B signals" MILITARY COMMUNICATIONS CONFERENCE. MILCOM 2002. PROCEEDINGS. ANAHEIM, CA, OCT. 7 - 10, 2002, IEEE MILITARY COMMUNICATIONS CONFERENCE, NEW YORK, NY : IEEE, US, vol. VOL. 1 OF 2, 7 October 2002 (2002-10-07), pages 224-231, XP010632104 ISBN: 0-7803-7625-0
- D5: BOLDING G ET AL: "A COMPUTATIONALLY EFFICIENT METHOD OF TIMING AND PHASE ESTIMATION IN TDMA SYSTEMS USING A

PREAMBLE SEQUENCE" INTERNATIONAL JOURNAL OF SATELLITE
COMMUNICATIONS, JOHN WILEY AND SONS, US, vol. 13, no. 6,
November 1995 (1995-11), pages 441-452, XP000979620 ISSN: 0737-2884

Invention 1

Clarity, conciseness and support of the claims

2.1 Although claims 15 and 29 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.

2.2 According to claim 1, the equalizer compensates *optimally* the determined channel response. Firstly, *optimal* compensation in the sense of equalization is not a well-defined term, since equalization algorithms may be derived according to many different optimization criteria such as ZF, MSE, SNR, BER, etc. Including the word *optimal* in a claim thus merely suggests that an optimization criterium was used in the derivation of the equalizer algorithm, without actually limiting the scope of claim 1. Secondly, the description discloses algorithms for computing the equalizer coefficients **without** disclosing the derivation or stating which optimization criterium was used in the derivation. Therefore, claiming *optimal* compensation is not supported by the disclosed embodiments. Consequently, claim 1 does not meet the requirements of Article 6 PCT.

It is pointed out to the applicant that the same objection is also applicable to the other independent claims 15, 29, 43.

2.3 According to claim 1, at least one adjustable coefficient of the equalizer is set such that the equalizer response compensates the determined channel response. Since it is the aim of the equalizer to compensate the channel response and it is clear to the person skilled in the art that this is achieved by setting equalizer coefficients, such a formulation is regarded as an attempt to define the subject-matter in terms of the result to be achieved. Consequently, claim 1 does not meet the requirements of Article 6 PCT. An independent claim 1 that meets the requirements of Article 6 PCT would have to define how the equalizer coefficients

are set more precisely.

It is pointed out to the applicant that the same objection is also applicable to the other independent claims 15, 29, 43.

- 2.4 According to claim 1, a channel response is determined for at least one frequency point and at least one adjustable coefficient of the equalizer is set such that the equalizer response compensates the determined channel response. Such a definition of the subject-matter of claim 1 clearly includes the possibility that a channel response is determined at a plurality of frequency points and that the equalizer comprises a plurality of coefficients. If, however, only one adjustable coefficient of the equalizer is set, it becomes entirely unclear to the person skilled in the art how equalization may be achieved at all. The description is also completely silent on the subject. The scope of claim 1 is thus broader than justified by the extent of the description and the Figures. Consequently, claim 1 is not supported by the description and fails to meet the requirements of Article 6 PCT.

It is pointed out to the applicant that the same objection is also applicable to the other independent claims 15, 29, 43.

- 2.5 According to the description, there is a precisely defined relationship between the number of frequency points that are determined and the actual configuration (i.e. structure and computation of coefficients) of the equalizer. See, for example, pages 26-27 which show that for two frequency points, the phase equalizing part consists of the concatenation of a complex allpass filter, a phase rotator, and a symmetric three tap FIR, whereas for three frequency points, the phase equalizing part consists of the concatenation of a complex allpass filter, a phase rotator, a real allpass filter and a five tap FIR. It thus appears that technical features describing these relationships are necessary to define the invention, or in other words, are essential features which are necessary for the solution of the problem to which the invention relates (namely, optimally compensating the channel response at the selected frequency points). Consequently, claim 1 does not meet the requirements of Article 6 PCT.

It is pointed out to the applicant that the same objection is also applicable to the other independent claims 15, 29, 43.

In that context, the applicant is also drawn to the fact that claiming separate phase equalizers, and separate amplitude equalizers, as attempted in the dependent claims of the application, is not supported by the description, since this encompasses variations that are neither disclosed nor foreseen (for example claims 1, 7, and 10 in combination which claims the concatenation of a phase equalizer designed for two frequency points with an amplitude equalizer designed for three frequency points).

- 2.6 The applicant's attention is also drawn to the fact that on page 27 of the description it is stated that in the case of one frequency point the coefficient for the phase rotator in equations (9) is relevant. According to equations (9), however, the coefficient for the phase rotator is always computed based on two frequency points. This inconsistency casts doubt on whether the embodiment pertaining to only one determined frequency point is sufficiently disclosed in the sense of Article 5 PCT.

Novelty and Inventive Step

- 3.1 It is pointed out to the applicant that the scope of the independent claims is so broad (see also the objection raised at paragraphs 2.3 - 2.5) that the disclosure of any communication system which somehow determines a channel frequency response and compensates therefor (i.e. a standard OFDM system) may be read onto these claims.

- 3.2 Document D1 discloses, according to all the features of claim 1,

Method for use in an equalization of a channel by means of an equalizer (see Abstract), wherein said channel uses a certain frequency band for a transfer of signals (see Figure 1), said method comprising:

- determining a channel response for at least one frequency point within said frequency band used by said channel (see Section 4.1, lines 5-8 and lines 21-23); and
- setting at least one adjustable coefficient of said equalizer such that an equalizer response compensates optimally the determined channel response at said at least one selected frequency point (see equations 3.1 and 3.2 and

the objection raised at paragraph 2.1 of this opinion)

Therefore, claim 1 is not novel over the disclosure of D1 in the sense of Article 33(2) PCT.

3.3 Likewise, document D2 discloses, according to all the features of claim 1,

Method for use in an equalization of a channel by means of an equalizer, wherein said channel uses a certain frequency band for a transfer of signals (see column 3, lines 50-61), said method comprising:

- determining a channel response for at least one frequency point within said frequency band used by said channel (see column 25, lines 41-60 which shows that the frequency response is measured at P points of the frequency spectrum in question); and
- setting at least one adjustable coefficient of said equalizer such that an equalizer response compensates optimally the determined channel response at said at least one selected frequency point (see column 25, line 55-60 which shows an equation to calculate N equalizer coefficients based on P measured points of the frequency spectrum; see also column 14, lines 12-15 which discloses using the equalizer coefficients to compensate for the channel response)

Therefore, claim 1 is not novel over the disclosure of D2 in the sense of Article 33(2) PCT.

3.4 Independent claims 15, 29 and 43 contain the same technical features as method claim 1, albeit formulated as a signal processing device, a signal processing system, and a software program product. Therefore, either document D1 or document D2 disclose all the features of these claims as well, and consequently claims 15, 29 and 43 do not meet the requirements of Article 33(2) PCT.

3.5 The additional features of the dependent claims 2, 5-7, 9, 11-14, 16, 19-21, 23, 25-28, 30, 33-35, 37, 39-42 do not add anything which would result in novel and inventive independent claims in the sense of Articles 33(2) and (3) PCT, because these features are either known from the above prior art D1-D2, for example,

- claim 2: See document D1, equations (3.1) and (3.2)
- claim 5: See document D1, equations (3.1) and (3.2)
- claim 6: See document D1, equations (3.1) and (3.2)
- claim 11: See document D2, which discloses a single-carrier system
- claim 12: See document D1, which shows a filter bank based multicarrier system and/or a transform based multicarrier system
- claim 14: See document D1, which discloses a channel which is processed in an analysis-synthesis filter bank configuration

or common design measures, for example,

- claim 7: See document D2, equation (15) which shows that the allpass filter may be represented as a cascade of phase rotators. It would therefore be an obvious measure for the person skilled in the art to split a higher order allpass filter into a phase rotator part and a lower order allpass filter part.
- claim 13: The use of an equalizer in a MIMO system is a common measure of the person skilled in the art

3.5 The additional features disclosed in dependent claims 9, 23, and 37 are not disclosed in any document cited in the search report, nor are they derivable therefrom in an obvious way. Therefore, it appears that dependent claim 9, 23, and 37 could meet the requirements of Articles 33(2) and 33(3) PCT, if the objections raised under Point 2.5 were overcome.

Invention 2

Clarity, conciseness and support of the claims

4.1 According to claim 8, a channel response is determined for two frequency points and at least one coefficient of a symmetric 3-tap FIR filter is set. If, however, only one or two of the equalizer's three coefficients are set, it becomes entirely unclear to the person skilled in the art how equalization may be achieved at all. The scope of claim 8 is thus broader than justified by the extent of the description and the Figures. Consequently, claim 8 is not supported by the description and fails to meet the requirements of Article 6 PCT.

It is pointed out to the applicant that the same objection is also applicable to the other claims of invention 2, i.e. claims 10, 22, 24, 36, 38.

- 4.2 According to the description, there is a precisely defined relationship between the number of frequency points that are determined and the actual configuration (i.e. structure and computation of coefficients) of the equalizer. See, for example, pages 26-27 which show that for two frequency points, the phase equalizing part consists of the concatenation of a complex allpass filter, a phase rotator, and a symmetric three tap FIR, whereas for three frequency points, the phase equalizing part consists of the concatenation of a complex allpass filter, a phase rotator, a real allpass filter and a five tap FIR. It thus appears that technical features describing these relationships are necessary to define the invention, or in other words, are essential features which are necessary for the solution of the problem to which the invention relates (namely, optimally compensating the channel response at the selected frequency points). In other words, a claim 8 which claims amplitude equalization on its own is lacking essential features.

Furthermore, claiming separate phase equalizers, and separate amplitude equalizers, as attempted in the dependent claims of the application, is not supported by the description, since this encompasses variations that are neither disclosed nor foreseen (see example mentioned under Point 2.5).

Consequently, claim 1 does not meet the requirements of Article 6 PCT.

It is pointed out to the applicant that the same objection is also applicable to the other claims of invention 2, i.e. claims 10, 22, 24, 36, 38

Novelty and Inventive Step

- 5.1 Document D6 discloses, according to the essential features of claim 8,

Method for use in an equalization of a channel by means of an equalizer (see paragraph 1), wherein said channel uses a certain frequency band for a transfer of signals (see paragraph 3), said method comprising:

- determining a channel response for at least one frequency point within said frequency band used by said channel (see paragraphs 11-27 which disclose

splitting the frequency band into 3-80 communication channels and measuring average power, i.e. the channel response, at each one of these channels); and

- setting at least one adjustable coefficient of said equalizer such that an equalizer response compensates optimally the determined channel response at said at least one selected frequency point (see paragraphs 27 and 31 which disclose an equalizer which attenuates the channels if they exceed a predetermined threshold, and whereby the equalizer comprises variable amplitude devices which are set accordingly)

wherein in case said at least one frequency point comprises two frequency points (see paragraph 11 which mentions 3-80 frequency points, i.e. two frequency points are comprised), setting said adjustable coefficients comprises for an equalization of the amplitude of said channel setting at least one coefficient of a Finite Impulse Response filter part of said channel equalizer (see paragraphs 30-31 and Figure 2, which discloses setting the variable amplitude devices according to established transversal filter design techniques)

- 5.2 Claim 8 differs from the disclosure of document D6 in that it specifies a symmetric 3-tap Finite Impulse Response filter, whereas document D6 discloses an FIR filter of length N without specifying any symmetry properties.

The problem to be solved by claim 8 may thus be regarded as how to construct an equalizer that does not change the phase of its input signal.

Claim 8 solves this problem by employing a three-tap symmetric Finite Impulse Response Filter. This solution, however, is regarded to lack an inventive step for the following reason:

The disclosure of document D6 mentions setting the amplitude devices of the transversal filter (the coefficients of the Finite Impulse Response filter) according to established filter design techniques. The design of symmetric linear phase filters is one of such established filter design techniques well known to the person skilled in the art. Since the person skilled in the art knows that symmetric filters solve the problem of linear phase equalization, he would readily modify the disclosure of document D6 using equalizers of various lengths (i.e. 3, 5 or more

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taps) in order to solve the problem posed.

Consequently, claim 8 lacks an inventive step in the sense of Article 33(3) PCT.

- 5.3 It is pointed out to the applicant for the reason outlined above under Point 5.2, claims 10, 22, 24, 36, 38 of invention 2 also lack an inventive step in the sense of Article 33(3) PCT.

Industrial applicability

6. The requirements of Article 33(4) PCT are met.